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Relevance evaluation of engineering master's program in Peru

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Abstract

In a context of mass higher education, it is necessary to ensure not only quality but also the relevance of engineering master's programs, namely the appropriateness of the objectives and outcomes to the needs and interests of the program beneficiaries. After a literature review we analyzed the evaluation models of three organizations in Peru: the Board of Evaluation, Accreditation and Certification of the University Education Quality – CONEAU, the Institute of Quality and Accreditation of Computing, Engineering and Technology - ICACIT and the Pontificia Universidad Catolica del Peru. The result of this study is a model for relevance evaluation for an engineering master´s program in Peru.

Keywords: Relevance evaluation, engineering education, master's program;

1. Introduction

In this paper we propose a model to evaluate the relevance of an engineering master's program in Peru. The master's program is considered as a project and its role and relevance must be evaluated, so that the program may be adapted to meet the needs and interests of stakeholders. Existing literature and bibliographies regarding the role of higher education have been reviewed, and an analysis of the evaluation criteria and measurements for accreditation and quality assurance used by Peruvian institutions has been made.

It is important to evaluate the relevance of a master's degree in engineering in a developing country for two principal reasons. The first one is in respect to the direct impact that engineering has on the competitiveness and economic development of a country and region. The second one regards the context in which the master's degree is studied. In a world that is faced with the widespread of higher education and economic globalization, postgraduate students are confronted by a model of international accreditation, wherein the student may find that his program does not meet international standards.

The study will consider professional master's degree in engineering but not the master's degrees in research (which are necessary for PhD studies) that are provided by a public or private university. Therefore it is necessary start from a theoretical framework that describes the process of obtaining a master's degree in engineering from a university, and defines specific indicators for expressing the role of the program in Peru

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2. Theoretical framework

The majority of universities are organized according to the structures of scientific disciplines (mode 1). The research used is based on this organization form, curriculum, and the results produced by this discipline. However, a new model for the production of knowledge has been proposed by Gibbons (1998). Within this model, characteristics of learning and teaching are established, which regard the use of research tasks and the role of teaching within the university. This can be referred to as mode 2.

According to Gibbons in mode 2 we have a "distributed system of knowledge production" where universities no longer have a monopoly on knowledge production. In mode 1, problems are posed and solved within a rigid and regimented context, which is controlled by the interests of a specific, and mainly academic, community. Conversely, in Mode 2, knowledge is produced through application, in which concrete problems must be solved within complex social, economic, political, and environmental systems. Mode 1 refers to a discipline and Mode 2 is transdisciplinary. In mode 2 have greater social responsibility, to exchange technology and share resources through networks, associations and partnerships.

The use of mode one, in regards to its research plans and curriculum within a discipline, is utilized similarly in all universities around the world. In mode 1 it is necessary that methods and tools become increasingly advanced, and it tends to be that the scientific research plans around the world were established by developed countries. Thus developed countries also decide how to evaluate the quality and relevance of higher education training programs. Consequently, developing countries are forced to accept challenges and priorities that do not interest or pertain to them. However, in order to participate at the international level, they must follow the plans set by the international scientific community (Gibbons, 1998).

The majority of universities do not question the ingrained belief that mode 1 is the only way to produce fundamental knowledge. However, mode 1 does not provide education regarding the application of knowledge, which is precisely what is needed by developing countries. These countries need to solve local problems in the short term by applying the skills needed in complex situations. These countries cannot wait until the structured decisions made by disciplines come to address their specific needs, nor can they wait for national governments to include local problems within research policies., As a result, universities should be organized according to mode 2. Mode 2 also permits the universities to share resources that are scare in developing countries, as well as to exchange technology through networks and partnerships between universities, businesses and the state (Nowotny, 2003).

In Mode 2 knowledge production refers to applied research in a particular context, research focused on problems, and projects with multidisciplinary teams working cohesively to solve specific problems. It does not refer to researchers but rather identifiers, solvers and mediator of the problem (Reich 1993). Thus a master's degree in engineering should develop in students the competences necessary for them to perform within a system of production and distribution of knowledge. The methodology that is best suited to this approach is project-based learning (Palma, 2011).

The relevance is not linked to the generation of new knowledge - making discoveries – and instead depends more on the ability of higher education institutions to engage with others in the production of knowledge and innovation.. As a result, this means that universities will have a more explicit and dynamic role in economic development, either nationally or regionally. If universities do not assume this new role, they will be marginalized because other producers of knowledge will meet and satisfy the demand for innovation and advancement (Knights, 2010).

In Peru, the number of students enrolled at the graduate level is equal to the number enrolled at the undergraduate level (Piscoya, 2006). However, the number of degrees awarded is only a fraction those enrolled: 10% (Guerra-García, 2006). This situation is also seen in other countries throughout the region.

3. Methodology

The steps followed for developing the model for evaluating the relevance of an engineering master's program is as follows:

a. Define the beneficiaries, stakeholders (and their needs and interests) and the general objectives of a master's in engineering program, as well as its applicability.
b. Define the concept of project relevance and describe the context in which the program develops.
c. Establish whether or not the program relevance is evaluated through the accreditation models used by major institutions, regarding the specific issue within Peru.
d. Propose the variables and indicators for evaluating the appropriateness of the pro in accordance with the above.

4. Results

4.1. Beneficiaries and stakeholders

The main beneficiaries of an engineering master's programs are students. In Peru, most of these master's degrees are studied part-time. Students attend university in search of lifelong learning, mainly because they want to specialize in one branch of engineering to improve their job performance. They need specialized knowledge so that they may apply this knowledge and create innovations in their field. An individual who studies a master's degree full time will allow them to have a more competitive resume and an advantage.

Employers are also beneficiaries of these programs because they benefit from the improvement in work performance of students. The local and national communities are also beneficiaries because they will have more competitive professionals to solve their problems.

The universities that teach master's programs are amongst the key stakeholders because through this program the university is performing part of its mission, not only are they training educational elites but also are making advances in research, community integration and thereby contributing to development. A master's degree in engineering therefore seeks to train professionals to develop solutions to problems pertaining to their specialty. Graduates should be able to understand complex systems, work creatively in a team, and exchange technology and resources (Crawley, 2008).

4.2. Concept of relevance

The definition of the project relevance used in this paper is the European Commission definition (1999): Relevance is the appropriateness of the explicit objectives of a program, with regard to socio-economic problems the program is meant to solve. Relevance is important especially in the aforementioned evaluation, because the focus is on the strategy chosen and the justification for choosing it.. In a mid-term evaluation is advisable to evaluate whether the socio-economic context has evolved as expected and whether this evolution calls into question the relevance of particular initial objectives.

If we examine an engineering master's program as a project, we can determine whether or not this program is relevant. We can do so my determining if the objectives posed are adapted to the educational needs of the students, if they are appropriate to the university interests, and if they solve the socio-economic and contribute to community development.

To generate relevance and applicability, the university should organize its program following the scheme of mode 2 that is outlined by Gibbons (1998). That is, the university should be part of a system of knowledge production and distribution, and establish networks and partnerships with businesses and developed governments in order to create a research outline based on development problems to be solved.

The final dissertation project should be mainly applied research to solve concrete problems in the context of a company or a current issue in development. If the issue is not proposed by the student, then it must be proposed by

the university from a projects portfolio that it is working in collaboration with other institutions in this "system of production and distribution of knowledge".

4.3. Relevance evaluation in Peru

We analyzed the criteria for relevance evaluation of a master's program used by the Board of Evaluation, Accreditation and Certification of the University Education Quality - CONEAU, the Institute for Quality and Accreditation of Computing, Engineering and Technology - ICACIT and the Pontificia Universidad Catolica del Peru.

4.3.1. CONEAU criteria

CONEAU maintains 84 standards for the evaluation of a master's program in general. Table 1 shows the dimensions, factors and criteria used.

Table 1. CONEAU quality model for accreditation of master's program

Dimension	Factor	Criterion	Standars
Program management	Planning, organizing, directing and controlling	Strategic Planning	1 – 5
		Organization, management and control	6 – 14
Student training	Teaching and Learning	Educational Project	15 – 27
		Teaching and learning strategies	28 y 29
		Development of teaching and learning activities	30 - 34
		Evaluation of learning and improvement actions	35 y 36
		Students and graduates	37 – 46
	Research	Generation and evaluation of research projects	47 – 56
Support services for student training	Faculty	Teaching work	57 – 64
		Researching work	65 – 72
	Infrastructure and equipment	Environments and equipment for teaching and learning, research, administration and welfare	73 y 74
	Welfare	Implementation of welfare programs	75 – 78
	Financial Resources	Financing the implementation of the graduate program	79 – 81
	Interest Groups	Association with interest groups	82 – 84

In the CONEAU evaluation model standards were identified that serve to evaluate the relevance master's program according to the points made in the theoretical framework. The results are shown in Table 2.

Table 2. CONEAU model standards to evaluate the master's program relevance

CRITERION	STANDARD	SOURCE OF VERIFICATION
Educational Project	15. Academic Unit justifies supply of master's program.	Report on the study of the social demand of master's program Application for admission
	23. The curriculum links the teaching-learning process with the research process	Syllabus
	25. The curriculum incorporates the results of research master's program	Report on research results Report on curriculum evaluation Syllabus
	26. The curriculum is evaluated annually for update	Report on curriculum evaluation Syllabus Documented procedure
Teaching and learning strategies	28. Students are in accordance with the teaching and learning strategies applied	Evaluation Report Surveys and interviews with students Satisfaction with implementation of strategies for teaching – learning
Students and graduates	45. The academic unit has a tracking system implemented graduated	Documents that support the implementation of the system Evaluation tools used Percentage of Graduates Impact of the degree Percentage of graduates engaged in university teaching Percent of graduates admitted to academic programs abroad
Generation and evaluation of research projects	47. The master's program research applies established theories for generating other knowledge in the disciplinary area concerned.	Regulation of degrees Evaluation Report
Links with stakeholders	53. Events are held to discuss and spread research in the Master's students, teachers and community	Records of attendance Surveys and interviews with teachers Number of events for the dissemination of research results
	82. The master's program has an advisory council composed of representatives of principal stakeholder	Resolution creating the advisory council Minutes of advisory council meetings
	84. The stakeholders believe that their participation contributes to the development of the master's program	Surveys and interviews with stakeholders Satisfaction of stakeholders

We believe that the approach used by the CONEAU for the design of these standards is that of Gibbons' mode 1. Specifically, it is a university structured by disciplines where the role of the university is to "transfer" knowledge rather than "exchange" knowledge and technology. It is apparent in standards 47 and 53. The positive element of the model is the inclusion of an "Advisory Council" to link master's program with interest groups or stakeholders.

4.3.2. ICACIT criteria

The criteria used by ICACIT for accrediting engineering programs (including master's programs) have been taken from the ABET criteria translation made by the Institute of Electrical and Electronics Engineers - IEEE Inc.

The criterion for evaluating a degree is shown in Table 3.

Table 3. ICACIT criteria

N°	Criterion
1	Students
2	Program Educational Objectives
3	Program Outcomes
4	Continuous Improvement
5	Syllabus
6	Faculty
7	Facilities
8	Support
9	Program Criteria

While these standards hardly compare to the level of detail set forth by CONEAU, the criterion "2. Program Educational Objectives "includes the creation of an Advisory Council, which should be actively involved in updating the curriculum and system of continuous improvement. Principally, is it to say that a link to stakeholders must be created.

4.3.3. PUCP criteria

For PUCP "quality higher education" is a dynamic concept, modifiable and extensive, embracing all areas of activity of the university as learning processes, research and services.This level of responsiveness that maintained by the institution shows that the program is adaptable to changing needs, and seeks continuous improvement. The model has three dimensions of analysis: training program design, program implementation and program outcomes. Table 4 shows the areas considered in the model.

Table 4 PUCP evaluation model for mater's program

DIMENSION	AREA
Training Program Design	Objectives
	Curriculum
Implementation of the training program	Origin of candidates
	Teachers
	Administrative support
	Satisfaction with the spaces and educational facilities
Training program outcomes	Satisfaction with training
	Satisfaction with training received
	Academic and professional performance of graduates

In the PUCP model, relevance evaluation indicators were identified according to the points made in the theoretical framework. The results are shown in Table 5.

Table 5. PUCP model standards to evaluate the master's program relevance

AREA	INDICATOR	SOURCE OF VERIFICATION
Curriculum	7. There are lines of research or areas of specialization that guide and enhance the master's final project.	Interview with the master's program Coordinator Survey of students Survey of teachers Document containing the lines of research
Satisfaction with training received	31. Level of student satisfaction with the training.	Survey of students
	32. Level of graduates satisfaction with the training (two to three years of graduation)	Survey of graduates
	33. Level of employers satisfaction with the graduates performance (two to three years of graduation)	Survey of employers
	34. There is a system for monitoring the graduates performance	Survey of graduates Survey of employers

PUCP model is also based on a Gibbons' Mode 1, as clearly shown by the indicator 7. Notable is the link to the transdisciplinary approach through surveys of graduates and employers. It is not required of the program to fulfill research projects based on applicable problems, nor is participation in networks or associations required of the teachers.

4.4. Proposal of indicators for evaluation of an engineering master's program

The following proposal does not seek to change the models of quality evaluation for accredited master's programs. Furthermore, since globally the graduate accreditation processes follows an international standards-based approach, the relevance of a local program can not be guaranteed (Miñan, 2011). Relevance in this proposal can be considered as a characteristic that can be applied to all dimensions and factors of quality models, and can be considered as another factor within the model.

In a developing country like Peru, which has experienced over ten years of continuous economic growth as well as has vast natural resources and a relatively young population, a master's degree in engineering should be closely linked to the local environment. Such a program could provide specialized knowledge to students, allow them to develop skills to solve problems in complex systems, and conduct applied research focused on problem solving. Furthermore, the program should encourage the university to interact with businesses, industries and governmental laboratories, sharing resources and sharing knowledge. Therefore, to evaluate the relevance of an engineering master's program it is proposed on the following factors, indicators and sources of verification (Table 6).

Table 6. Indicators proposal for relevance evaluation for engineering master's program

FACTOR	INDICATOR	SOURCE OF VERIFICATION
Program outcomes	The master's program develops competencies established by ABET (2011) for engineering education and it uses project-based learning approach	Surveys of students Surveys of graduates Curriculum
Curriculum	The courses promote transdisciplinarity and innovation.	Curriculum, syllabus. Relations between program's knowledge areas
	The syllabus is updated according to the requirements of students and graduates.	Surveys of students Surveys of graduates Survey of employers
Faculty	Teachers participate in networks or scientific and professional associations. They have academic mobility.	Certifications Intellectual production Agreements
Research	Master's final projects solve problems in companies or develop into an innovation project of the University in partnership with another institution.	Academic records to master's final projects. Contracts Agreements
	The organization of the university facilitates multidisciplinary research focused on problems	Organization and Functions Regulations of the University Projects Contracts
Environment	Master's program and educational objectives satisfy a demand for education in the region.	Market Research Surveys and interviews with stakeholders
	Undergraduate programs or specialization are related to the master's program.	Curriculum
	There are effective relationships with similar programs at other universities, companies and other	Agreements Projects
	The master's program has an advisory council composed of representatives of major stakeholders	Resolution creating the advisory council Minutes of advisory council meetings Surveys and interviews with stakeholders
Graduates	There is a system of monitoring the graduates performance	Survey of graduates Survey of employers

5. Conclusions

An engineering master's program in Peru is relevant if it meets two conditions: first, if it satisfies the student's needs, namely, to acquire specialized knowledge and to develop skills to solve complex problems in a given territory. Second if it helps the university to have a major role in the system of knowledge production and distribution, and allows the university to conduct applied research, thus solving problems in partnership with local businesses and public entities, and finally that it shares resources and exchanges technology. The proposed model for the relevance evaluation of an engineering master's program emphasizes these two aspects.

Quality evaluation models for the master's programs Peru,were analyzed assuming an organization based in disciplines in universities. This approach does not help to promote the relevance of the learning process.

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